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AN APPLICATION OF GOAL PROGRAMMING TO NATIONAL ECONOMIC DEVELOPMENT PLANS

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CERTIFICATE

This is to certify that the present work on An Application of Goal Programming to National Economic Development Plans , by Anoop Kumar Srivastava, has been carried out under my supervision and has not been submitted elsewhere for the award of a degree.

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ANOOP KUMAR SRIVASTAVA

CONTENTS

ABSTRACT

The problem of economic development in India acquired new dimensions after independence. An era of five year plans began in 1951 for the economic development of the country. With the objective of evolving efficient plans, Pandit Jawahar Lal Nehru inaugurated studies on planning for national development in the Indian Statistical Institute in Calcutta on November 3, 1954. Since then, researchers, both at home and abroad, have been working on planning models. But none of them have viewed the planning problem from the multi-criteria optimization angle.

In this thesis an attempt is made to model the economic development problem as a multi-criteria optimization problem. Goal programming concepts have been advantageously utilized to solve the model. A five year plan for the period 1978-79 to 1982-83 has been charted out to demonstrate the methodology suggested in this thesis.

CHAPTER I

ECONOMIC PLANNING AND ITS METHODOLOGY

1.1 Economic Development:

For a poor country like India, the importance of economic development can never be over-emphasized. As to what constitutes the economic development, has been debated among the intelligentsia time and again. There can be no single and sacrosanct opinion on this issue. But it has been generally accepted that economic development is a wider concept than economic growth. Though, the economic growth is indeed the most important single factor in economic development and is essential to it, development incorporates the qualitative aspects of growth also. Development implies real improvement in the quality of life. In any civilised community, this is judged by the standards of education, public health, medical care, water supply, sanitation, recreation, cultural activities, etc. Moreover, to the developing countries like India, development also means "catching up with the West", the substitution of machines and technology for back-breaking toil, the equality of distribution of benefits of development, the elimination of foreigners from positions of dominance and control in their economies, the realization of national

economic independence vis-a-vis the rest of the world, increased prestige and respect abroad, and the like.

But, how do we achieve this economic development? India has vast amount of natural and human resources. But these are grossly under-utilized. This has made India even more poorer. A recent report by the World Bank[7] has placed India among the 10 poorest countries of the world (India's per capita GNP has been estimated at dollar 190). In such conditions the task of national development becomes even more difficult. Therefore, we should fully utilize our natural and human resources. But at the same time, the twin objectives of optimum development of resources and their equitable distribution to satisfy the aspirations of the people can not be ignored. Development is, thus, provided by planning, also termed as economic planning in the literature. To achieve the desired results, it is not only necessary to implement the plan efficiently, but to evolve an efficient plan is an equally imperative necessity as someone has rightly said," It is as dangerous to implement an inefficient plan efficiently as it is to implement an efficient plan inefficiently."

What is economic planning? It has been discussed in the next section.

1.2 Economic Planning:

Economic planning can be defined as "the making of major economic decision - what and how much is to be produced and to whom it is to be allocated by the conscious decision of a determining authority, on the basis of a comprehensive survey of the economic system as a whole."[3]

Economic planning, according to Government of India, is "essentially a way of organizing and utilizing resources to maximum advantage in terms of defined social ends. The two main constituent of the concept of planning are (i) a system of ends to be pursued and (ii) knowledge as to available resources and their optimum allocation."[4]

Thus, economic planning would involve a correct assessment of the resources available, charting out a programme of economic utilization of the resources so that each unit of resource is used in the most efficient manner possible, the allocation of resources among different lines of investment so that optimum overall results are obtained and also the adoption of ways and methods to ensure that the increased output is shared by the different sections of the community in an equitable manner. To prepare and carry out such a programme of action, a central agency is required which would be able to coordinate the various units of production and assume responsibility for the efficient allocation and employment of the resources. Thus planning directly

involves state interference, so that the greater degree of planning in an economy, the wider and more comprehensive becomes the scope of government activity. In this sense, an economic plan may be viewed as a "programme for the strategy of a national government in applying a system of state interference with the play of market forces, thereby conditioning them in such a way as to give an upward push to the social process."[5]

1.3 Stages in Economic Planning:

Economic planning involves following stages:

1.3.1 Setting Development Goals:

A plan is a design for achieving a desired objective or a set of objectives. To plan effectively, it is necessary for policy makers and planners to understand the meaning of economic development, which has already been discussed in Sec. 1.1.

Quite often, the set of objectives or goals are conflicting in nature. The efforts should be made to reconcile these conflicts in ways which will best promote the totality of the objectives.

1.3.2 Setting Development Strategies:

Every development plan rests on one or more strategies. Since there can be more than one alternative of achieving the task, any strategy adopted implies also the rejection of

alternative strategies. It is, therefore, of crucial significance as to which strategy is adopted and at what time. According to I.G. Patel, "Strategy implies essentially a deliberate choice - a choice of the point and timing and manner of attack on the problem at hand."[6]

A strategy can be that of ascribing different priorities to various sectors of the economy. For instance, it could be giving top priority to agriculture (as implicit in first five year plan, 1951-52 to 1955-56) or it could be giving higher priority to industrialization and emphasis on basic or heavy industries (as in second to fourth five year plans). It should be realized that improvement in agriculture can not be brought out without industrialization and there is no sense in industrilizing the economy indiscriminately without increasing the purchasing power of rural masses who draw their sustenance mainly from the agriculture. It is, therefore, obvious that none of the strategies are exclusive. All of them are functionally related, and all of them can and should be reconciled within a broad working strategy of economic development.

1.3.3 Appraising Development Potentials:

It begins with a general examination of nature, levels, structure and direction of past and current production. Depending upon these, planners should assess how much further growth might be achieved, by practical measure within a given

span of time? Besides these, the potentials of economy for generating domestic finance and foreign exchange are also essential to the appraisal process.

1.3.4 Setting the Growth Targets:

Setting the appropriate output targets is corner-stone to the process of economic planning. If targets are set unrealistically high, they will lead to overly ambitious planning and to frustration and disappointment, as well as to foreign exchange and inflationery crisis. On the other hand, if targets are set too low, the country will loose some of the progress that could otherwise have been achieved. It is important, therefore, that the major targets be both ambitious and feasible. The output targets, also known as basic targets, need to be supported by complementary objectives for consumption and investment, finance, exports and imports, and the like.

1.3.5 Setting the Resource and Investment Targets:

The resources to finance the development plan consist primarily of -

(i) those which can be diverted from current consumption (government surplus on current account and private savings),

(ii) and such savings as the nation may have in the past accumulated in excess foreign exchange holdings,

(iii) and such grants, loans and investments as may be obtained from abroad.

Government surplus on current account not only means the budgetary surplus, but also the net surplus of all the financial activities in which the government is engaged - i.e., the surplus of the public sector as a whole.

It is important to note that neither can all the resources be invested nor can all the resources be used for current consumption if proper development were to take place. People's capacity to invest is expressed by marginal propensity to invest. Attempts should be made to maximise the marginal propensity to invest in such a manner that best overall results are obtained. At the same time, it should be the endeavour of a developing nation to minimize the dependence on foreign countries to the best of her capacity.

1.3.6 Allocating Resources and Responsibility for Investment:

Next step is to allocate resources to various sectors of the economy. The resources should be so allocated that goals and targets, that were set earlier, are achieved to the maximum possible extent.

Almost as important as the question of how investment is to be allocated is the question of by whom the investments shall be made - by the public or by the private sector, by the government or by private individuals, cooperatives and firms. This question should not be decided on ideological grounds, but rather on the pragmatic basis of what, in the given case, will yield the best results.

The above steps in economic planning, however, lead only to a draft plan. The next step is to formulate economic policies for implementing the plan. Finally, a draft plan will go through a number of variations before it is ready to be submitted for final review and approval.

1.4 Methodology for Economic Development:

The importance of evolving an efficient plan for national development is too well known to be discussed here. Efforts should be made to design appropriate methodology to carry out above mentioned steps of the economic planning and arrive at a draft plan. Though, a considerable amount of work has been done in this regard, the problem has been primarily attempted with single objective optimization techniques only. For instance, some investigators have developed models to maximize the total consumption on the ground that this will lead to general welfare of the people. This may not be true. The fact that one or more sectors of the economy may grow at the cost of the other sector or sectors, has been ignored completely. There is every possibility that total consumption can be increased at present by investing more resources for the growth of large-scale consumer products industry because the demand of consumer products is elastic in nature unlike the demand of unmanufactured agricultural products which is inelastic. But this may lead to the neglection of agricultural sector which provides sustenance

to nearly seventy percent of the population. Under such circumstance the large-scale industrial sector will grow at the cost of agricultural sector. The question is, is it desirable? The answer is, definitely not. This is not only undesirable from the point of view of agricultural sector but also from the point of view of industrial sector. According to Keyne's theory of macro-economics, the growth of industry is limited by income levels of the consumers. Thus, if income of population employed in agriculture is kept at low level, who will buy the products of large-scale consumer products industry? Meeting the objective of employment generation requires that due attention be paid to small-scale industrial sector. Basic input industries such as steel, power and coal, etc. also need to be given due attention or otherwise growth of other sectors will not be possible. Needless to mention that priorities need to be given to different sectors for balanced growth of the economy. The nature of problem of planning is, therefore, that of multiple-criteria optimization. In the past decade or so, a quantitative technique called Goal Programming has been developed to solve such multiple criterion optimization problems.

In this thesis an attempt is made to model the economic development problem as a multi-criteria optimization problem. Goal programming concepts have been advantageously utilized

to solve the model. For the purpose of demonstration of the methodology, a five year plan for the period 1978-79 to 1982-83 has been charted out.

1.5 Composition of Thesis:

Next chapter deals with the literature review on planning models for India.

The model has been developed in the third chapter. The solution procedure to solve the model has been discussed in detail in the fourth chapter.

Chapter five elaborates the computation of optimum investment plans for the period 1978-79 to 1982-83 using different strategies and the results have been compared.

The conclusions and suggestions for further work are outlined in Chapter Six.

CHAPTER II

LITERATURE REVIEW ON PLANNING MODELS FOR INDIA

Pandit Jawahar Lal Nehru, the former Prime Minister of India, inaugurated studies relating to planning for national development in the Indian Statistical Institute in Calcutta on 3 November, 1954. Since then the Institute has been actively engaged in studies on planning in collaboration with the Planning Commission, the Central Statistical Organization and other government agencies, and a considerable amount of work has been done.

Under the auspicies of the Indian Statistical Institute, Ragnar Frisch[8] introduced a multi-sector optimisation model in computational form for India in 1955. He called his model as an Experimental Plan Frame . He did not however present any final results of the model.

Jan Sandee[9] too, under the auspices of the Indian Statistical Institute, presented a terminal year optimization planning model classifying 13 sectors of the economy. This model is based on an assumed economic situation in 1960, and analyses the Indian economy in 1970. The 1953-54 inter-industry table prepared at ISI was mainly the basis for current flow transactions. Maximization of total consumption was selected as the only target in this linear programming model.

In the year 1962, a 65 sector input-output model was used for giving a perspective of development in 1961-76.[10] The sectors were classified in such a manner so as to get a near triangular structure of inter-industrial transactions. Only desk calculators were used for calculations. Input coefficients were directly estimated on the basis of various sources of data. For this model, public consumption expenditure, gross fixed capital formation, export and import vectors were exogenously estimated. Changes in stocks formed part of the model. Private consumption vector was estimated by making certain assumptions regarding reduction in the inequality of distribution of consumption expenditure and reduction of the poverty.

A consistency model of India's 4th plan using a 30 sector input-output model with 1960-61 as base year and 1970-71 as target year was formulated by Allan Manne and Ashok Rudra[11]. In this model a part of the investment was exogeneously determined while the other part was estimated with the help of capital output ratios and the stock flow conversion factors. In the case of a few important sectors imports were determined as part of the model. For the remaining sectors imports were exogeneously determined.

Although various exercises were carried out by different divisions of the Planning Commission, the Commission for the first time issued a Technical Note on the Approach to the

Fifth Plan of India in April 1973,[12] where the detailed model used for preparing the approach to the fifth plan was given. This model was an open static Leontief type based on a 66 sector input-output table compiled by the Planning Commission for the year 1965 and updated to 1973-74 at 1971-72 prices. The aggregate gross fixed investment was estimated from a macro-model by using global incremental capital output ratio. The sectoral composition was exogenously specified. Imports were treated endogenously in the model. This model is structurally similar to two models discussed just above.

The model used for sixth plan[13] is again a static Leontief type of consistency model and is similar to the model used for the fifth plan.

In all the models described above, public consumption and export vectors were exogenously estimated. Stocks were treated endogenously as part of the model. Total consumption expenditure exogeneously estimated was allocated among different sectors by keeping redistribution in mind and making use of Engel curves.

In addition a number of optimization models both terminal year and inter-temporal have been formulated by individual research workers. Soon after Manne and Rudra Model[11], Bergsman and Manne[14] worked out an almost consistent model for the fourth and fifth plans of India. This model

tries to take into account the balances of intervening years also. It is, therefore, an inter temporal but consistency model. Models of Manne and Rudra[11] and Bergsman and Manne[14] are also given in India Plan Models by Ashok Rudra[15].

A single period optimization model was worked out by T.E. Weiskoff[16]. Other optimization dynamic as well as inter-temporal models have been formulated by: Eckaus and Parikh[17], Chakravarti and Lefeber[18], Tendulkar[19], Manne and Weiskoff[20] and S.P. Gupta[21].

Eckaus and Parikh[17] have presented multi-sectoral and inter-temporal models applied to India. These models are addressed to the problems of determining the optimum levels of savings and investments over time, and the related problems of intersectoral and intertemporal distribution of investment and output and use of foreign exchange resources. They are L.P. models that are adapted in various ways in specific applications. The basic structure is common in all these models.

The model of Tendulkar[19] is a multi-sectoral, single period, optimizing programming model that explicitly incorporates two primary bottleneck constraints on economic growth, namely domestic savings and foreign exchange. The problem posed by the model is comparatively static in nature. It consists of making an optimal jump from the initial conditions

in the base year to the target year of the planning horizon by maximizing the criterion function subject to the constraints operating on the system in the terminal year.

The paper of Manne and Weiskoff[20] reports a model that has been christened as DMS (Dynamic Multi-Sector). DMS is intended to quantify the implications - both at a macro-economic and at a sectoral level - of alternative time patterns for the inflow of external assistance, sector by sector, internally consistent paths are generated for domestic production, imports, exports, consumption and investment. This model is clearly related to those of Eckaus and Parikh[17] and Chakravarti and Lefeber[18].

The model presented by S.P. Gupta[21] uses dynamic linear programming with non-linear variations to check the consistency and feasibility of Indian development planning.

Thus, it can be seen that none of the investigators mentioned above has attempted to solve the economic development problem with multi-criteria optimization techniques. In this thesis an attempt has been made to make use of goal programming, a multi-criteria optimization technique, to solve economic development problem.

CHAPTER III

DEVELOPMENT OF THE MODEL

3.1 Introduction:

The structure of the model developed in this chapter is static, open Leontief type (See Appendix 1). The model uses economic situation in the year preceding the planning horizon as input to the model. This year is known as base year for planning. For instance, 1977-78 is the base year for a five year plan 1978-79 to 1982-83.

The model also uses inter-industry flows in the latest year for which the input-output table is available. To distinguish it from the base year, this year has been denoted as input-output year subsequently. The inter-industry flows in the input-output year are used to estimate the technical coefficients to be used as input to the model. It has been assumed that inter-industry flows in the terminal year of planning follow the same pattern as in the input-output year. Apart from providing the technical coefficients, the data for input-output year have no further role to play in the model.

Further, the capital-output and stock-output ratios available from various sources are also used as input to the

model. (See Appendix 2 for an account on capital-output and stock-output ratios).

The model optimizes the economic situation in the terminal year of planning and then arrives at an optimum investment plan.

3.2 Stages in the Model Development:

There are following stages in the development of the model:

(i) Selection of the sectors of the economy,

(ii) Construction of equality constraints,

(iii) Construction of inequality constraints.

3.3 Selection of Sectors:

The very first step in the development of model is the selection of sectors. As far as the number of sectors is concerned, it should be as large as possible. The more detailed, the better. However, the number is limited by the availability of data and the difficulty encountered in computations.

The following points should be kept in mind while selecting the sectors of the economy:

(i) To avoid wastage of time and effort, none of the sectors selected should be very small. Small means using little investment and having little effect on the balance of trade.

(ii) The difference between sectors should be as large as possible while the difference within each sector as small as possible. This is to ensure that sectors are different and show a different development.

3.4 Construction of Equality Constraints:

3.4.1 Input-Output Equations:

Following symbols have been used in this section:

m = number of sectors

x_i = increase in gross output of i-th sector,

c_i = increase in consumption of i-th sector,

in_i = increase in fixed investment from the i-th sector,

e_i = increase in exports of i-th sector,

im_i = increase in imports of i-th sector,

n_i = increase in additions to stocks of i-th sector,

t_{ij} = technical coefficient from industry i to industry j.

$i = 1,2,\ldots, m$

$j = 1,2,\ldots, m$

All symbols listed above (except m and t_{ij}) stand for increase between base year and terminal year of the planning period. All variables are measured in Rs.

The first m equations of the model are of the Leontief type described in Appendix 1. These equations represent how the output of each sector is divided over inputs and the final

bill of goods. These equations are also termed as "balance equations" or "material balances" in the literature, as they balance supply and disposal. These are written as follows:

$$x_i = \sum_{j=1}^{m} t_{ij} x_j + c_i + in_i + e_i - im_i + n_i$$

$$i = 1, 2, \ldots, m \qquad (3.4.1)$$

It should be noted that consumption consists of government and private consumption. It should also be noted that only x_i, c_i, e_i and im_i constitute the variables in the model besides others to be discussed later. in_i and n_i are related to x_i and substituted in eqn. (3.4.1) with the help of investment equations derived in Sec. (3.4.2). It should be further noted that these variables will not figure at all in the model for certain sectors. For instance, there is no government and private consumption of fertilizers and therefore c_i for fertilizer industry will not figure in the model. Further in_i s will figure only for capital producing sectors as it is only from these sectors that gross capital formation takes place, e.g. engineering and construction sector. No e_i or im_i will figure for transportation, housing sectors.

3.4.2 Investment Equations:

The increase in output of various sectors have been related with investment and capital-output ratios (See

Appendix 2). These are known as investment equations. Following assumptions are made in writing the investment equations:

(i) Investment flow in every sector increases (or decreases as the case may be) linearly during the planning horizon.

(ii) All productive capacity is fully used by the base year. Thus all the growth in output during the planning horizon will have to come from new capacity created.

(iii) There is half year lag between investment and output.

(iv) Stocks will be at normal levels both in the base year and the terminal year. The rise in output will then be accompanied by an increase in stocks, dependent on that increase by means of the stock-output ratio.

Let investment in the base year be denoted by in_b, increase in investment per year by δ, increase in investment during the planning horizon by in, and capital-output ratio by r. The investment plan will then, look like as following:

Year	Investment
BASE	in_b
1st year of Planning	$in_b + \delta$
2nd year of planning	$in_b + 2\delta$
3rd year of planning	$in_b + 3\delta$
4th year of planning	$in_b + 4\delta$
5th year of planning (terminal year)	$in_b + 5\delta = in_b + in$

Therefore, investment in intervening period, I_1, to effect a rise of x in output during the planning period:

$$I_1 = 0.5\ in_b + (in_b + \delta) + (in_b + 2\delta) + (in_b + 3\delta)$$
$$+ (in_b + 4\delta) + 0.5\ (in_b + 5\delta)$$
$$= 5in_b + 12.5\ \delta \qquad (3.4.2.1)$$

But, investment to effect a rise of x is also related with capital-output ratio as follows:

$$I_1 = rx \qquad (3.4.2.2)$$

The right hand sides of equations (3.4.2.1) and (3.4.2.2) should be equal as left hand sides are same, i.e.,

$$5in_b + 12.5\delta = rx$$
$$2.5(2in_b + 5\delta) = rx$$
$$2in_b + 5\delta = 0.4\ rx$$
$$5\delta = 0.4\ rx - 2in_b\ ; \quad \text{But as } 5\delta = in$$

$$in = 0.4\ rx - 2in_b \qquad (3.4.2.3)$$

However, total investment, TI, in the planning period is given as:

$$TI = (in_b + \delta) + (in_b + 2\delta) + \ldots + (in_b + 5\delta)$$
$$= 5in_b + 15\delta$$
$$= 5in_b + 3\ in \qquad (3.4.2.4)$$

Similarly, if stock additions in the base year be denoted by n_b, increase in stock additions during the planning

horizon by n, and stock-output ratio by s, then,

$$n = 0.4\ sx - 2n_b \tag{3.4.2.5}$$

Equations (3.4.2.3) and (3.4.2.5) are general in nature. These should be written for i-th sector and substituted into equation (3.4.1).

The equation (3.4.2.5) for i-th sector is written as following:

$$n_i = 0.4\ s_i\ x_i - 2n_{bi} \tag{3.4.2.6}$$

For a pair of sectors (i, j), the equation (3.4.2.3) is written as follows:

$$in_{ij} = 0.4\ r_{ij}\ x_j - 2in_{bij} \tag{3.4.2.7}$$

where in_{ij} is increase in investment from sector i to sector j, r_{ij} is capital output ratio from sector i to sector j and in_{bij} is investment from sector i to sector j in the base year.

For sector i,

$$in_i = \sum_{j=1}^{m} in_{ij} \tag{3.4.2.8}$$

The equations (3.4.2.6) and (3.4.2.8) are substituted back into equation (3.4.1). Finally, the sum of investments in various sectors should be equal to total investment, I,

$$I = \sum_{i=1}^{m} in_i + \sum_{i=1}^{m} n_i + in_{im} + in_{irr} \tag{3.4.2.9}$$

where in_i and n_i are given by equations (3.4.2.8) and (3.4.2.6). A new variable, in_{im}, called increase in investment in activities to bring about improvement in agriculture such as (i) green manuring (ii) small scale irrigation, (iii) improved seeds, (iv) crop rotation, (v) dry farming, etc., has been introduced. The increase in total investment, I, too is a variable. The variable in_{irr} denotes the increase in investment on irrigational projects.

3.4.3 Consumption Equation:

The sum of consumptions in various sectors should be equal to total consumption, C, which too is a variable,

$$C = \sum_{i=1}^{m} c_i \tag{3.4.3}$$

3.4.4 Agricultural Sector Equation:

The rise in output of agricultural sector is also related with increase in fertilizer applied , irrigation projects executed in_{irr} , and improvement in agriculture in_{im} as following:

$$x_a = K_1 t_{fa} x_a + K_2 \left[5 in_{irrb} + 3 in_{irr}\right] + K_3 \left[5 in_{imb} + 3 in_{im}\right] \tag{3.4.4}$$

where,

t_{fa} = technical coefficient from fertilizer to agricultural sector,

x_a = rise in gross output of agricultural sector,

K_1 = a coefficient representing rise in output of agricultural sector per unit increase in fertilizers applied,

K_2 = a coefficient representing rise in output of agricultural sector per unit investment on irrigational projects,

K_3 = a coefficient representing rise in output of agriculture per unit investment on improvement of agriculture,

in_{irrb} = investment on irrigation in the base year,

in_{imb} = investment on improvement of agriculture in the base year,

in_{irr} = increase in investment on irrigation during the planning horizon,

in_{im} = increase in investment on improvement during the planning horizon.

It can be seen that 2nd and third terms in the Eqn. (3.4.4) have been obtained from general equation (3.4.2.4).

3.5 Construction of Inequality Constraints:

3.5.1 Investment Constraints:

There is an upper limit to total investment I, and lower limits to investment in each sector.

(i) Let p_{in} = marginal propensity to invest

= rise in investment for unit rise in total income.

then, $\frac{p_{in}}{1-p_{in}}$ = rise in investment for unit rise in consumption, C

($\because$ total income $\cong$ consumption + investment)

then, I will never exceed $\frac{p_{in}}{1-p_{in}}$ C, i.e.

$$I \leq \frac{p_{in}}{1-p_{in}} C \qquad (3.5.1.1)$$

The constraint represented by relation (3.5.1.1) takes care of steps outlined in Sec. 1.3.5.

(ii) Investment in the terminal year can not fall below zero.

Investment in the terminal year = in_b + in

Therefore,

$$in_b + in \geq 0$$

substituting in from Eqn. (3.4.2.3),

$$in_b + 0.4\ rx - 2in_b \geq 0$$

$$0.4\ rx \geq in_b \qquad (3.5.1.2)$$

This is general inequality relation written for a component of investment. For i-th sector, equation (3.5.1.2) is written as,

$$0.4\ \left(\sum_{j=1}^{m} r_{ij} + s_i\right) x_i \geq \left(\sum_{j=1}^{m} in_{bij} + nb_i\right) \quad (3.5.1.3)$$

where the symbols carry the meaning as stated earlier.

It should be noted that the set of inequality constraints represented by relation (3.5.1.3) are fundamentally different from set of investment equations represented by (3.4.2.8). While equations (3.4.2.8) are related with investments from capital producing sectors, the inequalities (3.5.1.3) govern the investments into the various sectors.

It is also necessary to mention here that attempts have failed to estimate capital output ratios from capital producing sectors to agricultural sectors. However there is only one capital producing sector i.e. construction sector which figures for agricultural sector in terms of irrigation projects undertaken. For this purpose another variable namely in_{irr}, already encountered in Sec.3.4.4 has been defined. This should also be ensured that investment on irrigational projects also does not fall below zero:

$$in_{irrb} + in_{irr} \geq 0 \qquad (3.5.1.4)$$

It should be noted that the variable in_{irr} is unrestricted in sign, unlike all other variables which are greater than or equal to zero.

However, an upper limit can be placed upon this variable due to resource constraint,

$$in_{irr} \leq in_{irru} \qquad (3.5.1.5)$$

where in_{irru} is upper limit to in_{irr}.

An upper limit should also be placed on the increase in agricultural improvement in_{im} due to limitation of resources as follows:

$$in_{im} \leq in_{imu} \qquad (3.5.1.6)$$

where, in_{imu} is upper limit to in_{im}.

As $in_{im} \geq 0$, it will be ensured that investment in agricultural improvement will not fall below zero in the terminal year.

3.5.2 Consumption Constraints:

Let,

C = Increase in total consumption

C_b = Total consumption in base year,

then,

Relative rise in consumption $= C/C_b$

Let,

p = relative rise in population in the planning period, to be projected from census data.

Then,

per capita increase in consumption $= \frac{C}{C_b} - p$

Now, if expenditure elasticity of i-th sector is denoted by γ_i, then,

The per capita increase in consumption of i-th sector is,

$$\xi_i \left(\frac{C}{C_b} - p \right)$$

and, therefore, the total increase in consumption of i-th sector is,

$$\frac{c_i}{c_{bi}} = \xi_i \left(\frac{C}{C_b} - p \right) + p$$

$$c_i = \xi_i \frac{c_{bi}}{C_b} (C - pC_b) + p\, c_{bi}$$

$$c_i = \xi_i \frac{c_{bi}}{C_b} C - \xi_i\, pc_{bi} + pc_{bi} \qquad (3.5.2.1)$$

where, c_{bi} = consumption of i-th sector in the base year.

The equation (3.5.2.1) helps in writing inequality consumption constraints for each sector.

It should be noted that if equality constraints for each sector were written as given by (3.5.2.1), the model would become too rigid i.e. consumption is made to follow exactly the Engel curves. A limited supply of one sector, in that case, however unimportant, could hold down total consumption because the consumers were supposed not to demand any more of the other commodities as long as supply of that scarce commodity did not increase. To avoid this, consumption has been allowed a limited freedom around the Engel pattern. Constraints have been put at p percent of base year consumption above and below the Engel curves for each sector as following:

$$c_i \leq \xi_i \frac{c_{bi}}{C_b} C - \xi_i \, pc_{bi} + pc_{bi} + pc_{bi}$$

$$c_i \leq \xi_i \frac{c_{bi}}{C_b} C - \xi_i \, pc_{bi} + 2pc_{bi} \qquad (3.5.2.2)$$

and,

$$c_i \geq \xi_i \frac{c_{bi}}{C_b} C - \xi_i \, pc_{bi} + pc_{bi} - pc_{bi}$$

$$c_i \geq \xi_i \frac{c_{bi}}{C_b} C - \xi_i \, pc_{bi} \qquad (3.5.2.3)$$

The relationships (3.5.2.2) and (3.5.2.3) thus constitutes the inequality consumption constraints for the model.

3.5.3 Foreign Trade Constraints:

General guidelines can be given for constructing foreign trade constraints as following:

(i) Every type of exports is limited by what purchasers will buy,

(ii) No imports can rise above world supply,

(iii) Total exports net of imports should be maintained at least at the base year level. This is to ensure that foreign exchange situation will not deteriorate,

(iv) Uncertainties in production levels of uncertain sectors should be taken care of by the export-import inequality constraints. For instance, margin should be allowed to import food-grains in case an emergency arises,

(v) The export net of imports of those sectors, which showed good signs in the base year, should be maintained at least at the base year level,

(vi) Also, efforts should be made to increase exports net of imports in these sectors which showed surplus exports in the base year. But this is limited by the production capacities of the sectors.

(vii) The net imports in those sectors which imported more than what they exported in the base year should be contained.

3.5.4 Other Constraints:

Other constraints can be written after appraising development potentials (Sec. 1.3.3) in terms of variables such as x, c, e, in, s, etc. To make the model realistic, these constraints should be incorporated after careful examination of nature, levels, structure and direction of past and current production.

A model as the one described in the present work can never be complete. It can only be made more and more realistic by collecting more and more real data and incorporating them in the form of real constraints.

CHAPTER IV

COMPUTATION OF THE OPTIMUM INVESTMENT PLAN

Following are the steps in the computation of the optimum investment plan:

4.1 Setting Development Goals:

As already stated in Sec. (1.3.1) the first stage in the process of economic planning is setting development goals such as removal of unemployment, reduction in poverty and inequalities, and continued progress towards self-reliance, etc. These are social goals and can be attained by optimizing with respect to complementary objectives for consumption and investment, finance, exports and imports, etc. This has been covered in Sec. (4.3.2). The quantitative aspect of economic development i.e. the economic growth is optimized using goal programming and is discussed in Sec. (4.3.1). However, it should be noted that in a programming model, goals of economic policy can be stipulated not only by what is chosen to be maximized, but also by the content of the constraints.

4.2 Setting Development Strategies:

Next step for planners is, as discussed in Sec. (1.3.2), to assign certain priorities to various sectors as part of

their strategy. Various sectors of the economy such as agriculture, small-scale sector, mining and manufacturing, transportation, and services etc. are allowed to grow in the desired manner to achieve the social goals set earlier.

This can be done as follows:. Let there be m sectors in the economy for the purpose of resource allocation. Priorities assigned to different sectors are denoted by $P_1, P_2, \ldots, P_m$, where $P_1, P_2, \ldots, P_m$ are some positive numbers.

Then $P_1, P_2, \ldots, P_m$ are to be related as following:

$$n_1P_1 = n_2P_2 = n_3P_3 = \ldots = n_mP_m$$

where $n_1, n_2, \ldots, n_m$ are also positive numbers. These n_is are differe from n_is of Sec.3.4.

n_1 can be arbitrarily taken as 1 as $n_1, n_2, \ldots, n_m$ describes only the relationship between $P_1, P_2, \ldots, P_m$, then,

$$P_1 = n_2P_2 = n_3P_3 = \ldots = n_mP_m \qquad (4.2.1)$$

This relationship represents that sector 1 has been given n_2 times the priority given to sector 2, n_3 times the priority given to 3, and so on and so forth.

Selection of numbers $n_2, n_3, \ldots, n_m$ by the planners constitutes the strategy of planning. However, after a draft plan has been arrived at, it goes through many revisions and reviews by the government. The government may like to adopt a different strategy and thus assign different $n_2, n_3, \ldots, n_m$

thereby revising the plan . However, this is not the intent of the present work to study the behaviour of government's interference. The present work concerns itself only with arriving at a preliminary draft for further reviews and revision by the government.

4.3 Setting the Growth Targets:

As discussed in Sec. (1.3.4), the major targets should be both ambitious and feasible. To achieve this the procedure has been suggested in Secs. (4.3.1) and (4.3.2). Sec. (4.3.1) deals with basic targets and (4.3.2) with complementary objectives.

4.3.1 Basic Targets:

Gross outputs i.e. $x_1, x_2, \ldots, x_m$ constitute the basic targets. To ensure that targets be both feasible and ambitious, each one of the gross outputs $x_1, x_2, \ldots, x_m$ should be maximized subject to equality and inequality constraints (see Chapter III), hereafter referred to as real constraints. The value of objective functions so obtained are denoted by $T_1, T_2, \ldots, T_m$. But as stated in Sec. (4.2), the different sectors are allowed to grow in the desired manner specified by $P_1, P_2, \ldots, P_m$, the under achievement in targets $T_1, T_2, \ldots, T_m$ should be minimized subject to priorities $P_1, P_2, \ldots, P_m$. This is equivalent to:

$$\text{Min } Z = P_1 d_1^- + P_2 d_2^- + \ldots, + P_m d_m^- \qquad (4.3.1.1)$$

subject to,

(i) Real constraints:

These are given in Chapter III as equation nos. (3.4.1), (3.4.2.6), (3.4.2.8), (3.4.2.9), (3.4.3), (3.4.4), (3.5.1.1), (3.5.1.3), (3.5.1.4), (3.5.1.5), (3.5.2.2) and (3.5.2.3).

(ii) Goal constraints:

$$\begin{aligned} x_1 + d_1^- - d_1^+ &= T_1 \\ x_2 + d_2^- - d_2^+ &= T_2 \\ &\vdots \\ x_m + d_m^- - d_m^+ &= T_m \end{aligned} \qquad (4.3.1.2)$$

where d_1^-, d_2^-, ..., d_m^- are under achievements in targets T_1, T_2, ..., T_m, and d_1^+, d_2^+, ..., d_m^+ are respective over achievements.

Equation (4.3.1.1) can be modified with the help of (4.2.1) as:

$$\text{Min } Z = P_1 d_1^- + \frac{1}{n_2} P_1 d_2^- + \frac{1}{n_3} P_1 d_3^- + \ldots + \frac{1}{n_m} P_1 d_m^-$$

since P_1 is a positive number, it can be struck off, and therefore,

$$\text{Min } Z_1 = d_1^- + \frac{1}{n_2} d_2^- + \frac{1}{n_3} d_3^- + \frac{1}{n_4} d_4^- + \ldots \frac{1}{n_m} d_m^-$$

$$(4.3.1.3)$$

To arrive at an optimum plan, expression given by equation (4.3.1.3) should be minimized with respect to real and goal constraints.

4.3.2 Complementary Objectives:

This constitutes the qualitative aspect of economic development. The number of complementary objectives can be many. No fixed list of these can be given. The objectives have to be decided by the planners and should be selected at hand depending on what will promote best in a particular situation. Because of difficulty of defining social objectives such as employment generation, equality of distribution of wealth, etc. in terms of variables dealt in previous chapter, this part has been left out. But this can be said that, once objectives are defined in terms of mathematical variables, goal programming as suggested in Sec. (4.3.1) can be used in the same manner.

4.4 Allocating Resources:

This is an integral step with (4.3.1) and (4.3.2) as the optimum value of the variables obtained through these steps help in determining the resources to be allocated to different sectors with the help of equations (3.4.2.3), (3.4.2.4) and (3.4.2.5). Steps outlined in (1.3.3) and (1.3.5) have been taken care of in Secs. (3.5.4) and (3.5.1) respectively, i.e. while writing the constraints.

This completes the computation of the optimum investment plan.

Chapter V deals with the computation of optimum draft plan for period 1978-79 to 1982-83 to demonstrate the methodology suggested in this chapter.

CHAPTER V

DRAFT SIXTH PLAN (1978-79 TO 1982-83) COMPUTED

The period 1978-79 to 1982-83 has been selected because lot of real data were available for the year 1977-78. Moreover this period coincides with that of first rolling plan of Janta government, and therefore can be compared with that.

Computation of draft sixth plan can be discussed through following stages.

5.1 Selection of Sectors:

Following the concepts discussed in Sec. 3.3 and considering the limitations of computations and handling of data, the following sectors of the economy were finally considered:

	Sector Name	Code (Alphabetic)
1.	AGRICULTURE	AGRCL
2.	FOOD PRODUCTS	FOOD
3.	FERTILIZERS (CHEMICAL)	FERTL
4.	IRON AND STEEL	STEEL
5.	ENGINEERING	ENGG
6.	CONSTRUCTION	CONST

7.	OTHER LARGE-SCALE	OTHER
8.	SMALL-SCALE INDUSTRY	SMALL
9.	POWER	POWER
10.	COAL MINING	COAL
11.	TRANSPORTATION	TRANS
12.	HOUSING	HOUSE

Classification of above sectors has also been presented in Appendix 3.

5.2 Data Used and its Sources:

5.2.1 Input-Output Year:

The latest year for which the inter-industry transactions were available was 1970-71. The Input-Output table for 1970-71 has been published in the book entitled INPUT-OUTPUT TABLES FOR INDIA .[22] The table published is for 77 sectors, but for the purpose of the present work, this has been suitably aggregated into 11 of the 12 sectors (i.e. except housing sector) listed in Sec. 5.1. The table in aggregated form is given in Appendix 4. It should be noted that technical coefficients into and from housing sector are zero and have been used as such. This is because housing sector produces housing services, estimated at the rental value, and has no current inputs. Moreover, housing sector produces output only for the current consumption and thus there are no inter-industry flows associated with this sector.

5.2.2 Base Year:

The data for the base year 1977-78, such as gross outputs of sectors, consumption expenditure, investments, stock additions, exports, imports, expenditure on irrigation, investment on the improvement of agriculture, and gross-fixed capital formation, etc. have been compiled from different sources, [2], [23] and [24].

The base year data has been given in Appendix 5.

5.2.3 Other Data:

This relates to such data which need not necessarily be the data for the base year. For instance capital-output and stock-output ratios, marginal propensity to invest, expenditure elasticities, etc.

5.2.3.1 Capital-Output and Stock Ratios

These ratios have been compiled from different sources and are given in Appendix 6, along with their sources.

5.2.3.2 Percentage Rise in Population During the Planning Horizon.

Census, 1981 has estimated a growth of 24.75 percent in population over the last ten years. At this, compounded yearly growth rate turns out to be 2.2 percent. Same rate of growth has been assumed for the period between 1977-78 and 1982-83. Therefore, percentage rise in population during the planning horizon:

$$p = \left[1 + \frac{2.2}{100} \right]^5 - 1$$

$$= 0.12$$

$$p = 0.12$$

5.2.3.3 Marginal Propensity to Invest:

The net domestic capital formation in 1977-78 was 16.6 percent.[23] The gross capital formation could well have been of the order of 17 percent. The selection of a particular value of marginal propensity to invest is tantamount to setting the resource and investment targets (vide Sec. 1.3.5). It has been assumed that marginal propensity to invest will grow from a level of 17 percent at present to a level of 22 percent in the terminal year, that is an increase of nearly 1 percent annually. It is a sort of introducing a social goal and a behavioural constraint into the model, for it describes, though indirectly, the limits on the willingness of society to sacrifice present for future consumption.

5.2.3.4 Values of Coefficients K_1, K_2 and K_3:

(i) K_1 : This represents the rise in output of agriculture per unit of increase in fertilizers applied.

An additional food-grains of about 2 million tonnes can be obtained by applying about 4.5 lakhs tonnes of urea.[25]

Since the cost of food-grains and that of urea are of the same order,

$$K_1 = \frac{2.0}{0.45} = 4.44$$

But, the application of other fertilizers also need to be taken into account. As urea has got highest per unit rise in yield and its contribution being largest the value of K_1 can be roughly taken as 4.0.

(ii) K_2: This represents rise in output of agriculture per unit investment in irrigational projects.

The value of K_2 has been taken as 0.5.[26]

(iii) K_3: This represents rise in output of agriculture per unit investment in the activities undertaken for the improvement in agriculture.

The value of K_3 has been taken as 0.75.[26]

5.2.3.5 Expenditure Elasticities:

(i) Expenditure elasticity of demand for unmanufactured agricultural products has been assumed to be 0.8, as the demand for agricultural products is inelastic unlike in case of other products.

(ii) As the greater part of consumption of transport sector takes place in the form of trade margins paid as a part of the price of consumer goods, this quantity might well rise proportionately with total consumption i.e. the expenditure elasticity may be of the order of 1.0.

(iii) Nothing is known about the behaviour of other sectors separately and precisely. An average expenditure elasticity has been assumed for the remaining sectors. It has been found by taking the average of all the sectors which should be 1.0. The average is a weighted average based on consumption expenditure of different sectors. This is estimated as follows:

From the base year data:

Total consumption = Rs. 68,179.00 crores

Consumption of agricultural sector = Rs. 34149.78 crores

Consumption of transportation sector= Rs. 3547.00 crores

Therefore, other elasticities,

$$\epsilon_i = \frac{63179 - 34149.78 \times 0.8 - 3547 \times 1.0}{63179 - 34149.78 - 3547}$$

$$= 1.268$$

5.3 Constraints:

Only the foreign trade constraints will be listed below, as all other constraints are general in nature and have been incorporated in the programme itself with the help of data described in Sec. 5.2. The coefficients of foreign trade constraints are passed as the input to the programme.

(i) There are surplus exports in the agricultural sector. Attempts should be made to improve the situation further. But

it has been assumed that net exports can be doubled, at best. (It is necessary to keep upper limit to increase in net exports or otherwise the model will take advantage of that and one sector of the economy may grow at the cost of the other). Thus increase in net exports should be less than or equal to net exports in the base year, i.e.,

$$e_1 - im_1 \leq 463.2 - 61.2$$

$$e_1 - im_1 \leq 402.0 \qquad (5.3.1)$$

The next constraint on foreign trade of unmanufactured agricultural products is to take care of uncertainties. India has a buffer stock of 20 million tonnes. Even in the worst circumstances, India may not have to import more than 2.5 million tonnes of food grains. At a price of Rs. 2000 per tonnes, this comes to Rs. 500 crores.

Imports in 1977 - 78 = 61.2 crores

Increase in net imports = 500 - 61.2 crores

= 438.8 crores

Therefore,

$$im_1 - e_1 \leq 438.8$$

$$-e_1 + im_1 \leq 438.8 \qquad (5.3.2)$$

(ii) Among the food products, tea is the major foreign exchange earner. It has been assumed again that net exports food products can be doubled at best. Thus,

$$e_2 - im_2 \leq 897.0 - 61.2$$

$$e_2 - im_2 \leq 835.8 \qquad (5.3.3)$$

Lower limits on net imports should be placed so as not to allow the situation to deteriorate from what it is at present, i.e.,

$$im_2 - e_2 \leq 0.0$$

$$-e_2 + im_2 \leq 0.0 \qquad (5.3.4)$$

(iii) Imports of fertilizers in 1970-71 were to the tune of Rs. 70 crores and in 1977-78 to the tune of Rs. 200 crores. It seems unlikely that there will be net exports by 1982-83. However domestic production should be boosted and imports should be contained.

$$e_3 - im_3 \geq 0.0$$

$$-e_3 + im_3 \leq 0.0 \qquad (5.3.5)$$

(iv) Iron and Steel industry had positive net exports in 1977-78. This should be maintained:

$$e_4 - im_4 \geq 0.0$$

$$-e_4 + im_4 \leq 0.0 \qquad (5.3.6)$$

Attempts should be made to increase exports, but it is limited by the production capacity. Past experience has shown that it is not possible to export more than 10 percent of gross output, i.e.

$$e_4 - im_4 \leq 0.1\ x_4$$

$$-0.1\ x_4 + e_4 - im_4 \leq 0.0 \qquad (5.3.7)$$

(v) There were net imports in the engineering sector. These should be contained, i.e.,

$$e_5 - im_5 \geq 0.0$$

$$-e_5 + im_5 \leq 0.0 \qquad (5.3.8)$$

(vi) It is observed that exports and imports in the construction sector have been of the same order for quite some years. This should be ensured that there are no net imports in the terminal year, i.e.,

$$e_6 - im_6 \geq 0.0$$

$$-e_6 + im_6 \leq 0.0 \qquad (5.3.9)$$

Though there were a meagre Rs. 22 crores of net exports in 1977-78, efforts should be made to increase it. It has been assumed again that net exports can be doubled at best, i.e.

$$e_6 - im_6 \leq 132.00 - 110.00$$

$$e_6 - im_6 \leq 22.0 \qquad (5.3.10)$$

(vii) There were heavy imports in the other industrial sector. Efforts should be made to reverse this trend,

$$e_7 - im_7 \geq 0.0$$

$$-e_7 + im_7 \leq 0.0 \qquad (5.3.11)$$

But past experience has shown that the exports in other large scale-industry are limited to 5 percent of gross output, i.e.,

$$e_7 - im_7 \leq 0.05\ x_7$$

$$-0.05\ x_7 + e_7 - im_7 \leq 0.0 \qquad (5.3.12)$$

(viii) There were heavy imports in small-scale sector also. Efforts should be made to reverse this trend:

$$e_8 - im_8 \geq 0.0$$

$$-e_8 + im_8 \leq 0.0 \qquad (5.3.13)$$

Past experience has shown, in the case of small scale sector, that exports can not exceed 2 percent of gross output, i.e.,

$$e_8 - im_8 \leq 0.02\ x_8$$

$$-0.02\ x_8 + e_8 - im_8 \leq 0.0 \qquad (5.3.14)$$

(ix) There were positive net exports in the coal sector in 1977-78. The trend should be maintained, i.e.,

$$e_{10} - im_{10} \geq 0.0$$

$$-e_{10} + im_{10} \leq 0.0 \qquad (5.3.15)$$

But, at the same time, efforts should be made to increase the net exports since we have large amount of coal at our disposal. But looking at the limitations of our mining capacity and the poor quality of coal that we have, it

seems unlikely that net exports will become more than twice, i.e.,

$$e_{10} - im_{10} \leq 11.37 - 0.4$$

$$e_{10} - im_{10} \leq 10.97 \qquad (5.3.16)$$

(x) It is further desirable that total net exports should be maintained at the base year level, i.e.,

$$\sum_{i \neq 9}^{10} e_i - \sum_{i \neq 9}^{10} im_i \geq 0.0$$

$$- \sum_{i \neq 9}^{10} (e_i - im_i) \leq 0.0 \qquad (5.3.17)$$

(xi) There are upper limits to investments in irrigation and improvement in agriculture due to resource limitation. The increase in investment in case of improvement is not allowed to become more than twice, and not more than 1.5 times in case of irrigation. Thus,

$$in_{im} \leq 1263.61 \qquad (5.3.18)$$

and

$$in_{irr} \leq 0.5 \times 987.15$$

$$in_{irr} \leq 494.0 \qquad (5.3.19)$$

The above two constraints are in addition to foreign exchange constraints. The coefficients of these two constraints are also passed to the programme as input.

5.4 Optimization:

5.4.1 Strategy:

Parametric analysis will require different set of values of n_2, n_3, ..., n_{12} to be selected to solve the multi-criteria problem and study the results so obtained. As the number of these parameters is 11, the number of different combinations of n_2, n_3, ..., n_{12} will be too large to carry out such a parameteric analysis. Therefore, for the present work, m_7, i.e. the priority assigned to other large-scale sector, was selected to carry out the parametric analysis. The model was solved for five different values of m_7 keeping the values of other m as unchanged. Equivalently, the model was solved for five different strategies listed below:

(i) $P_1 = 1.5 P_2 = P_3 = 2P_4 = 2P_5 = 2P_6 = 0.5P_7 = P_8 = P_9 = P_{10} = 1.5P_{11} = 5P_{12}$

(ii) $P_1 = 1.5 P_2 = P_3 = 2P_4 = 2P_5 = 2P_6 = P_7 = P_8 = P_9 = P_{10} = 1.5P_{11} = 5P_{12}$

(iii) $P_1 = 1.5P_2 = P_3 = 2P_4 = 2P_5 = 2P_6 = 2P_7 = P_8 = P_9 = P_{10} = 1.5P_{11} = 5P_{12}$

(iv) $P_1 = 1.5P_2 = P_3 = 2P_4 = 2P_5 = 2P_6 = 3P_7 = P_8 = P_9 = P_{10} = 1.5P_{11} = 5P_{12}$

(v) $P_1 = 1.5P_2 = P_3 = 2P_4 = 2P_5 = 2P_6 = 4P_7 = P_8 = P_9 = P_{10} = 1.5P_{11} = 5P_{12}$

The above mentioned strategies imply that agriculture, fertilizer, small-scale, power and coal mining sectors have been given equal top priorities. Food products and transportation sectors have been given next highest priorities. Steel, engineering and construction sectors rank third in the order of priorities. Housing sector rank the lowest. The priority assigned to other large-scale industrial sector is varied to study its effect on other sectors of the economy.

5.4.2 Setting the Growth Targets:

To set the basic output targets, each one of the variables $x_1, x_2, \ldots, x_{12}$ was maximized separately. The values of the maximums so obtained formed the right hand sides of following goal constraints:

$$
\begin{aligned}
x_1 + d_1^- - d_2^+ &= 11554.30 \\
x_2 + d_2^- - d_2^+ &= 4648.51 \\
x_3 + d_3^- - d_3^+ &= 9514.26 \\
x_4 + d_4^- - d_4^+ &= 2144.39 \\
x_5 + d_5^- - d_5^+ &= 6803.34 \\
x_6 + d_6^- - d_6^+ &= 14251.14 \\
x_7 + d_7^- - d_7^+ &= 9673.23 \\
x_8 + d_8^- - d_8^+ &= 2947.82 \\
x_9 + d_9^- - d_9^+ &= 1485.64
\end{aligned}
$$

$$x_{10} + d_{10}^{-} - d_{10}^{+} = 714.93$$
$$x_{11} + d_{11}^{-} - d_{11}^{+} = 3155.08$$
$$x_{12} + d_{12}^{-} - d_{12}^{+} = 2675.60 \qquad (5.4.2)$$

The goal should be optimized subject to real constraints and goal constraints listed above.

5.4.3 Results:

The optimum investment plans obtained after adopting the strategies listed in Sec. (5.4.1) have been contained in Appendix 7, 8, 9, 10 and 11 respectively. Following observations can be made on the results:

(i) The total investment is about the same in all the plans, i.e. about Rs. 1,13,000 crores in all of them.

(ii) Redistribution of investment takes place as the priority assigned to other large-scale industry is varied.

(iii) As the priority assigned to other large sector is decreased, the output level and the investment in this sector decreases. At the same time there is generally a corresponding increase in the output levels and investments in other sectors.

(iv) The total investment in the agricultural sector (i.e. including irrigation and improvement) is same in all the plans. This is because agricultural sector has been given top priority (though along with some other sectors) and the the resources available at its disposal are fully utilized.

(v) The investment in food products sector is lowest in the 1st plan i.e. in which large-scale industrial sector has been given highest priority. In all other plans, the investment in this sector is nearly the same.

(vi) There is heavy investment in fertilizer sector in all the plans. This is not only due to fact that fertilizer sector itself has been given top priority but also because fertilizer forms an important input to the agricultural sector, which in turn, has been given top priority.

(vii) The investment in the steel sector is identical in all the plans. This indicates that inequality investment constraint in the steel sector is being satisfied as equality and therefore Rs. 2618.76 is the lowest limit of investment in the steel sector. Thus to boost the production of steel further, it need to be given higher priority.

(viii) The investment in engineering sector also is identical in all the plans. Same conclusions as those in the case the steel sector can be drawn for this sector.

(ix) Construction sector is getting nearly the same amount of resources in all the plans.

(x) The investment in power sector is nearly same in all the plans.

(xi) The investments in power, coal, transportation and housing sectors do not vary much over different plans.

(xii) The total investment is maximum in the first plan, i.e. in which the priority assigned to other large-scale industrial sector is highest, This shows that maximum growth is possible by investing more resources on other large-scale industrial sector. This is mainly due to the reason that other large scale sector is mainly consumer products based the demand of which is most elastic in nature.

CHAPTER VI

CONCLUSIONS AND SCOPE FOR FURTHER WORK

6.1 Conclusions

It can be concluded from the results discussed in Chapter V that methodology suggested in this thesis works successfully. The results obtained are consistent and also conform to the macro-economic theories. Thus it can be said that goal programming may prove to be a very powerful technique for attempting problems of economic development.

6.2 Scope for Further Work:

Needless to emphasize that there can be no dearth of scope for further work on planning models. In the present work, the goal programming technique has been applied to an open, static Leontief type of model. The technique can also be applied to closed, dynamic and consistent type of models. Further work can be directed towards qualitative aspects of economic development i.e. attempts can be made to model the social objectives as multi-criteria optimization problem. Attempts can also be made to link the quantitative and qualitative aspects of economic development and models developed to incorporate both the kind of objectives in a goal programme.

REFERENCES

1. Indian Economy through Plans, by Braj Kishor and B.P. Singh, National Publishing House, 1969.

2. Indian Economy, Nature, Problems and Progress, A.N. Agrawal, Vikas Publishing House, 1979.

3. H.D. Dickinson, Economics of Socialism, Oxford, London, 1939, p.41.

4. First Five Year Plan, Government of India, New Delhi, 1951, p. 7.

5. G. Myrdal, Economic Theory and Underdeveloped Regions, Vers, Bombay, 1958, p. 91.

6. I.G. Patel, The strategy of Indian Planning, Aspects of Indian Economic Development, op.cit., p. 116.

7. Associated Press report on p. 10 of Indian Express daily, dated August 12, 1981.

8. Planning for India, Selected Explorations in Methodology, Asia Publishing House, 1960, also published on p. 101 of Reference No. 15.

9. A Demonstration Planning Model for India, Jan Sandee, Asia Publishing House, 1960.

10. Perspective of Development: 1971-76, Implications of Planning for a Minimum Level of Living, Perspective Planning Division, Planning Commission (1962), also published in Reference No. 15, p. 191.

11. Allan S. Manne, Ashok Rudra and others, A Consistency Model of India's Fourth Plan, Sankhya Series B, Vol. 27, June, 1965.

12. A Technical Note on Approach to the Fifth Plan of India (1974-1979), Perspective Planning Division, Planning Commission, Government of India, April, 1973, also published in Reference No. 15, p. 191.

13. K. Alagh and K.C. Majumdar, Input-Output Model Used for 1978-79, Draft Plan, A Brief Outline, Paper presented at Sixth Input-Output Conference held in Bombay, 1978.

14. Joel Bergsman and Allan S. Manne, An Almost Consistent Inter-Temporal Model for India's Fourth and Fifth Plans, in Irma Adelman and Erich Thorbecke (eds.), Theory and Design of Economic Development, The Johns Hopkins Press, Baltimore, 1966, also published in Reference No. 15, p. 133.

15. India Plan Models, Ashok Rudra, 1975.

16. T.E. Weisskoff, A Programming Model for Import Substitution of India, Sankhya Series B, Vol. 29, 1967, also published on p. 163 of Reference No. 15.

17. R.S. Eckaus and K.S. Parikh, Planning for Growth, MIT Press, Cambridge, 1968, also published in Reference No. 15, p. 138.

18. S. Chakravarti and L. Lefeber, An Optimizing Planning Model, The Economic and Political Weekly (Bombay), Vol. 17, Nos. 5, 6, 7, 1965.

19. S.D. Tendulkar, Interaction Between Domestic and Foreign Resources in Economic Growth, Some Experiments for India, in H.B. Chenery, Studies in Development Planning, Harvard Univ. Press, Cambridge, Mass, 1971, also published in Reference No.15, p. 176.

20. Allan S. Manne and Thomas E. Weisskoff, A Dynamic Multisector Model for India, 1967-75, in A.P. Carter and A. Brody (eds.), Applications of Input-Output Analysis, North Holland Publishing Company, Amsterdam, 1970, also published in Reference No.15, p. 182.

21. S.P. Gupta, Planning Models in India with Projection to 1975, Vikas Publishing House Pvt.Ltd., New Delhi, 1973.

22. Input-Output Tables for India, Concepts, Construction and Applications, M.R. Saluja, Wiley Eastern Ltd.

23. India, A Reference Annual 1980, Publications Division.

24. Draft Fifth Five Year Plan 1974-79, Government of India, Planning Commission.

25. IEL Inaugurates..., (An ICI Publication).

26. Second Five Year Plan, Government of India, Planning Commission.

APPENDIX 1

INPUT - OUTPUT ANALYSIS

An input-output table (also known as transactions table, inter-industry table and the flow matrix) shows the flows of goods and services from each sector of the economy to different sectors of the economy over a specified period of time (usually a year). It may give other things as well, but the inter-industry flows are essential.

All the productive sectors of the economy are listed as rows, and again as columns. The table consists of four quadrants. The first quadrant gives the distribution of that part of the output which is absorbed by the producing sectors of the economy. This quadrant is most important and the largest part of the table. The second quadrant gives the consumption by the final consumers. Its components are, the private consumption expenditure, government current expenditure, gross fixed capital formation, changes in inventories, imports and exports. First and second quadrants together allocate the total output of each sector in the economy. The third quadrant consists of primary inputs (inputs not being produced) utilised by the different producing sectors. The primary inputs consist of the factor payments to labour and capital, indirect taxes, depreciation, etc.

First and third quadrants together show the total inputs used in production by each sector of the economy. The fourth quadrant records the primary inputs into final demand sectors. The fourth quadrant is generally omitted from the tables. Some typical entries like income of government employees, domestic services and aggregate of final demand vectors are shown in this quadrant.

A schematic arrangement of the input-output table is given below:

	Consuming Sectors				Final demand	Output
	1	2	...	m		
Producing Sectors						
1	X_{11}	X_{12}	...	X_{1m}	F_1	X_1
2	X_{21}	X_{22}	...	X_{2m}	F_2	X_2
⋮	⋮	⋮		⋮	⋮	⋮
m	X_{m1}	X_{m2}	...	X_{mm}	F_m	X_m
Primary Inputs	V_{11}	V_{12}	...	V_{1m}	$V_{1,m+1}$	
	V_{21}	V_{22}	...	V_{2m}	$V_{2;m+1}$	
	⋮	⋮		⋮	⋮	
	V_{k1}	V_{k2}	...	V_{km}	$V_{k,m+1}$	
Output	X_1	X_2	...	X_m		

X_{ij} is the amount of the output of i-th sector utilised as input for the production of j-th sector.

F_i is the amount of the final demand of the output of the i-th sector,

$$F_i = c_i + G_i + IN_i + E_i - IM_i + S_i$$

where,

c_i = private consumption

G_i = Government consumption

IN_i = Investment

E_i = Export

IM_i = Import

S_i = Changes in stock

V_{j}, = 1,2,..., k, j = 1,2,..., m are the different primary input rows

$V_{,m+1}$, = 1,2,..., k are the primary inputs into the final demand.

F_i is often called final bill of goods, which consists of,

$$F_i = c_i + G_i + OF_i$$

where OF_i is other final bill of goods, and

$$OF_i = IN_i + E_i - IM_i + S_i$$

The last row as well as column of the table gives the output for different sectors.

The basic assumption of an input-output model is that inputs are proportional to outputs, i.e.,

$$X_{ij} = t_{ij} X_j$$

where, t_{ij} = requirement of the output of sector i used as input for a unit level production of sector j.

t_{ij} s are known as the technical coefficients, or input-output coefficients or structural coefficients .

As already written,

$$X_i = \sum_j X_{ij} + F_i$$

$$X_i = \sum t_{ij} X_j + F_i$$

In matrix form:

$$(1-T)\ X = F$$

$$X = (1-T)^{-1}\ F$$

The production levels are thus fully determined by the vector F, the final bill of goods.

The above model is an open, static Leontief model.

A model can be closed vis-a-vis open and dynamic vis-a-vis static.

A Leontief model can be closed, partly or entirely, by relating components of the final bill of goods to the production levels by other relations than the input-output

relations of the open model. Consumer demand by commodities can be related to the income level which itself is a function of output.

The model is known as dynamic when it is closed by the linking of the investment part of the final bill of goods to output. The acceleration principle assumes that investment in fixed assests and in stocks is a function of the rate at which output grows. This rate, the (first) time difference of output, can be related to the difference in output in the year concerned with the output in some year of reference.

APPENDIX 2

CAPITAL - OUTPUT AND STOCK RATIOS

1. Definitions:

(i) The amount of fixed capital needed to produce a unit of a certain commodity per annum is called the Capital-Output Ratio of the production. This can be based on either gross output or net output (also known as value added or national income).

(ii) Fixed capital can be divided into engineering, and construction, etc. Engineering may further be divided into heavy engineering industry and other equipment industry, etc.

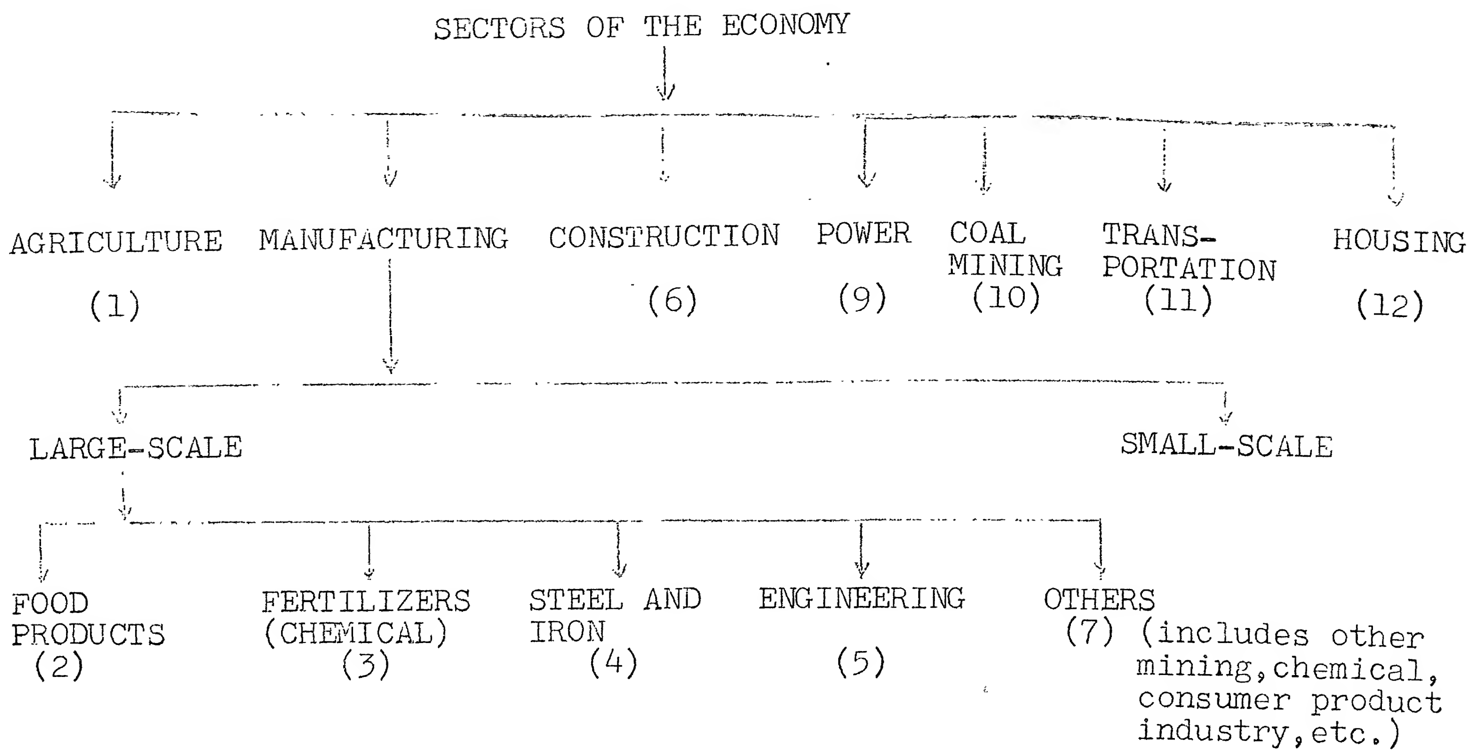
(iii) Normal level of inventories held is proportional to the output level, so that a constant stock output ratio is maintained.

2. Sources for Capital-Output and Stock Ratios:

The ideal sources for capital output and stock ratios would be well digested set of projects and realization reports of both new plants and extension of existing facilities. However, if these are unavailable one may go in for observations of existing assets and the output obtained from them.

APPENDIX 3

CLASSIFICATION OF SECTORS



NB 1: SERVICES SECTOR (Trade and distribution, Banks and insurance, Professions, Residential property, Public administration, Defence materials, etc.) has not been included as no input-output data were available for this sector.

NB 2: ENGINEERING AND CONSTRUCTION are the only two capital producing sectors.

INPUT-OUTPUT TABLE FOR 1970-71

Rs. in crores

	AGACL	FOOD	FERTL	STEEL	ENGG	CONST	OTHER	SMALL	POWER
AGRCL 1	2816.95	2550.22	0.12	0.94	21.77	264.03	987.81	468.89	0.00
FOOD 2	233.36	284.14	0.00	0.00	0.09	0.00	72.86	93.18	0.00
FERTL 3	367.94	0.07	3.23	0.00	0.00	0.00	0.00	0.00	0.00
STEEL 4	0.00	0.00	0.00	228.80	252.34	361.58	3.97	191.68	0.00
ENGG 5	3.09	15.71	0.00	2.40	309.52	67.95	34.37	33.74	0.00
CONST 6	0.00	0.00	0.00	31.20	8.29	1209.08	0.93	7.64	0.00
OTHER 7	122.14	61.44	54.72	53.32	253.72	139.88	2416.25	243.20	9.97
SMALL 8	19.39	55.07	3.36	40.43	109.88	369.85	168.45	114.36	0.02
POWER 9	75.98	18.58	24.52	28.30	30.60	16.58	178.26	34.83	0.00
COAL 10	1.24	4.44	6.57	41.89	4.09	23.21	31.40	16.66	64.65
TRANS 11	153.81	50.45	27.77	140.48	4.77	5.54	249.63	33.19	0.00
TO INPUT	3793.91	3040.13	120.29	567.74	995.09	2457.71	4143.92	1237.37	74.65
VA ADDED	18471.06	680.07	90.44	455.86	1976.63	2784.45	2763.25	913.01	595.89
G OUTPUT	22264.97	3720.20	210.73	1023.59	2971.73	5242.16	6907.18	2150.37	670.54

	COAL	TRANS	TIIF	HGC	IN	ENI	SA	OFBG	GO
AGRCL 1	0.00	0.00	7110.72	14969.05	0.00	-95.07	280.27	155.20	222[illegible]4.47
FOOD 2	0.0C	0.00	683.63	3015.99	0.00	115.30	-94.72	20.58	3720.20
FERTL 3	0.0C	0.00	371.24	0.00	0.00	-75.29	-85.22	-160.51	210.75
STEEL 4	0.00	0.00	1038.37	45.00	0.00	-38.27	-21.51	- 59.78	1023.59
ENGG 5	4.41	257.29	728.48	420.06	1741.78	24.89	56.51	1823.18	2971.73
CONST 6	0.00	0.00	1257.14	0.00	3984.59	0.42	0.00	3958.01	5242.16
OTHER 7	6.94	162.79	3524.39	3358.43	0.00	35.71	-11.34	24.36	6907.18
SMALL 8	1.89	1.40	884.11	1330.40	0.00	-71.31	7.17	-64.14	2150.37
POWER 9	10.64	20.66	438.95	116.64	0.00	0.00	114.95	114.95	670.54
COAL 10	32.27	56.81	283.23	21.34	0.00	2.39	9.05	11.44	316.01
TRANS 11	148.24	0.00	813.89	1445.50	0.00	0.00	0.00	0.00	2259.39
TO INPUT	204.38	498.96	17134.15						
VA ADDED	111.63	1760.43	30602.72						
G OUTPUT	316.01	2259.39	47736.87						

TIIF - Total Inter Industrial Flow
HGC - Household and Government Consumption
IN - Investment
ENI - Exports net of imports = Exports - Imports

SA - Stock additions
OFBG - Other Final Bill of Goods
GO - Gross Output
G OUTPUT - Gross Output

DATA FOR BASE YEAR (1977-78)

		PC	GC	EXPORTS	IMPORTS	GFCF	STOCKS	G OUTPUT	INVESTMENT ENGG	INVESTMENT CONST
1.	AGRCL	33869.70	280.08	463.20	61.20	0.00	341.65	48772.54	0.00	937.15[a]
2.	FOOD	6807.07	75.57	897.00	61.20	0.00	126.93	9916.33	253.86	101.54
3.	FERTL	0.00	0.00	0.00	200.00	0.00	175.74	1254.38	541.28	161.68
4.	STEEL	0.00	115.14	427.10	259.50	0.00	79.36	3489.87	1059.40	170.62
5.	ENGG	739.48	244.68	616.60	1158.10	10133.53	389.85	8686.44	4060.90	1908.62
6.	CONST	0.00	0.00	132.00	110.00	6229.39	876.09	16592.62	262.83	58.40
7.	OTHER	7269.80	409.85	898.10	2703.30	0.00	214.50	20781.40	2310.06	825.02
8.	SMALL	2863.05	190.15	210.0	442.90	0.00	250.99	6114.08	120.47	120.47
9.	POWER	210.29	62.38	0.00	0.00	0.00	0.00	2365.24	820.45	820.45
10.	COAL	47.61	1.15	11.37	0.40	0.00	11.98	1054.93	227.70	59.92
11.	TRANS	1237.00	2310.00	0.00	0.00	0.00	0.00	6219.57	476.58	762.52
12.	HOUSE	6008.00	418.00	0.00	0.00	0.00	0.00	6426.00	0.00	253.00

Investment in improvement of agriculture = 1263.61

GC - Government Consumption
PC - Private Consumption
GFCF- Gross fixed capital formation

a This represents investment in irrigation.

CAPITAL-OUTPUT AND STOCK OUTPUT RATIOS

	AGRCL	FOOD	FERTL	STEEL	ENGG	CONST	OTHER	SMALL	POWER	COAL	TRANS	HO…
ENGG	-	0.50	1.54	2.67	5.00	0.18	1.40	0.24	3.20	1.90	1.25	-
CONST	-	0.20	0.46	0.43	2.35	0.04	0.50	0.24	3.20	0.50	2.00	11.
STOCKS	0.15	0.25	0.50	0.20	0.48	0.60	0.13	0.50	-	0.10	-	-

Source: Ref. (9) and (26).

(Rs. crores)

	ENGG	CONST	STOCK	TOTAL
AGRCL	0.00	6417.75	1738.12	8155.87
FOOD	1776.73	710.69	888.36	3375.79
FERTL	11557.23	3452.16	3752.35	18761.74
STEEL	2118.82	341.23	158.71	2618.76
ENGG	8121.80	3817.25	779.69	12718.74
CONST	785.25	174.51	2617.52	3577.27
OTHER	13793.29	4926.18	1280.81	20000.28
SMALL	500.50	500.50	1042.70	2043.69
POWER	3979.53	3979.53	0.00	7959.06
COAL	1108.69	291.76	58.36	1458.81
TRANS	3384.43	5415.09	0.00	8799.51
HOUSE	0.00	13881.93	0.00	13881.93
TOTAL	47126.27	43908.58	12316.61	103351.46

INVESTMENT IN IMPROVEMENT OF AGRICULTURE = 10108.88

TOTAL INVESTMENT =113460.33

APPENDIX 7 CONTINUED

GROWTH RATES OF SECTORS WITH STRATEGY 1

1 AGRCL	4.34
2 FOOD	6.05
3 FERTL	44.13
4 STEEL	5.13
5 ENGG	4.29
6 CONST	5.26
7 OTHER	7.88
8 SMALL	6.23
9 POWER	8.86
10 COAL	9.24
11 TRANS	7.17
12 HOUSE	2.94

APPENDIX 8 : INVESTMENT PLAN FOR STRATEGY 2

(Rs. crores).

	ENGG	CONST	STOCK	TOTAL
AGRCL	0.00	6417.75	1738.12	8155.87
FOOD	2353.51	941.41	1176.76	4471.68
FERTL	10670.80	3187.38	3464.54	17322.72
STEEL	2118.82	341.23	158.71	2618.76
ENGG	8121.80	3817.25	779.69	12718.74
CONST	793.28	176.29	2644.26	3613.83
OTHER	13404.79	4787.42	1244.74	19436.95
SMALL	494.85	494.85	1030.93	2020.64
POWER	3768.34	3768.34	0.00	7536.69
COAL	1112.83	292.85	58.57	1464.26
TRANS	3998.57	6397.72	0.00	10396.28
HOUSE	0.00	13345.38	0.00	13345.38
TOTAL	46837.59	43967.88	12296.33	103101.80

INVESTMENT IN IMPROVEMENT OF AGRICULTURE = 10108.88

TOTAL INVESTMENT =113210.67

APPENDIX 8 CONTINUED

GROWTH RATES OF SECTORS WITH STRATEGY 2

1	AGRCL	4.34
2	FOOD	7.54
3	FERTL	42.31
4	STEEL	5.13
5	ENGG	4.29
6	CONST	5.30
7	OTHER	7.72
8	SMALL	6.18
9	POWER	8.52
10	COAL	9.26
11	TRANS	8.15
12	HOUSE	2.84

(Rs. crores)

	ENGG	CONST	STOCK	TOTAL
AGRCL	0.00	6417.75	1738.12	8155.87
FOOD	2345.52	938.21	1172.76	4456.49
FERTL	11543.75	3448.13	3747.97	18739.85
STEEL	2118.82	341.23	158.71	2618.76
ENGG	8121.80	3817.25	779.69	12718.74
CONST	799.20	177.61	2664.00	3640.80
OTHER	12018.57	4292.35	1116.02	17426.93
SMALL	490.36	490.36	1021.57	2002.30
POWER	3902.81	3902.81	0.00	7805.63
COAL	1184.31	311.66	62.34	1558.31
TRANS	4093.82	6550.13	0.00	10643.95
HOUSE	0.00	13324.42	0.00	13324.42
TOTAL	46618.96	44011.91	12461.18	103092.05

INVESTMENT IN IMPROVEMENT OF AGRICULTURE = 10108.88

TOTAL INVESTMENT =113200.92

APPENDIX 9 CONTINUED

GROWTH RATES OF SECTORS WITH STRATEGY 3

1 AGRCL	4.34
2 FOOD	7.52
3 FERTL	44.10
4 STEEL	5.13
5 ENGG	4.29
6 CONST	5.33
7 OTHER	7.12
8 SMALL	6.14
9 POWER	8.74
10 COAL	9.68
11 TRANS	8.30
12 HOUSE	2.83

APPENDIX 10 : INVESTMENT PLAN FOR STRATEGY 4

(Rs. crores).

	ENGG	CONST	STOCK	TOTAL
AGRCL	0.00	6417.75	1738.12	8155.87
FOOD	2155.58	862.23	1077.79	4095.60
FERTL	13710.68	4095.40	4451.52	22257.60
STEEL	2118.82	341.23	158.71	2618.76
ENGG	8121.80	3817.25	779.69	12718.74
CONST	866.13	192.48	2887.11	3945.72
OTHER	7359.40	2628.36	683.38	10671.14
SMALL	438.54	438.64	913.62	1790.70
POWER	4359.79	4359.79	0.00	8719.59
COAL	1271.49	334.60	66.92	1673.01
TRANS	4055.69	6489.12	0.00	10544.81
HOUSE	0.00	14530.30	0.00	14530.30
TOTAL	44457.93	44507.06	12756.86	101721.85

INVESTMENT IN IMPROVEMENT OF AGRICULTURE = 10108.88

TOTAL INVESTMENT =111830.72

APPENDIX 10 CONTINUED

GROWTH RATES OF SECTORS WITH STRATEGY 4

1	AGRCL	4.34
2	FOOD	7.04
3	FERTL	48.20
4	STEEL	5.13
5	ENGG	4.29
6	CONST	5.63
7	OTHER	5.01
8	SMALL	5.67
9	POWER	9.45
10	COAL	10.17
11	TRANS	8.24
12	HOUSE	3.07

APPENDIX 11 : INVESTMENT PLAN FOR STRATEGY 5

(Rs. crores)

	ENGG	CONST	STOCK	TOTAL
AGRCL	0.00	6417.75	1738.12	8155.87
FOOD	2155.58	862.23	1077.79	4095.60
FERTL	13710.68	4095.40	4451.52	22257.60
STEEL	2118.82	341.23	158.71	2618.76
ENGG	8121.80	3817.25	779.69	12718.74
CONST	866.13	192.48	2887.11	3945.72
OTHER	7359.40	2628.36	683.38	10671.14
SMALL	438.54	438.54	913.62	1790.70
POWER	4359.79	4359.79	0.00	8719.59
COAL	1271.49	334.60	66.92	1673.01
TRANS	4055.69	6489.12	0.00	10544.81
HOUSE	0.00	14530.30	0.00	14530.30
TOTAL	44457.93	44507.06	12756.86	101721.85

INVESTMENT IN IMPROVEMENT OF AGRICULTURE = 10108.88

TOTAL INVESTMENT =111830.72

APPENDIX 11 CONTINUED

GROWTH RATES OF SECTORS WITH STRATEGY 5

1	AGRCL	4.34
2	FOOD	7.04
3	FERTL	48.20
4	STEEL	5.13
5	ENGG	4.29
6	CONST	5.63
7	OTHER	5.01
8	SMALL	5.67
9	POWER	9.45
10	COAL	10.17
11	TRANS	8.24
12	HOUSE	3.07

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